JON ERIC SPENCER

RESUME

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JON ERIC SPENCER

Present Position:

Senior Geologist
Arizona Geological Survey
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Professional Registration: Arizona Registered Geologist #34513

Adjunct Position: Adjunct Researcher, Department of Geosciences, University of Arizona

Degrees: Ph.D. in geology, Massachusetts Institute of Technology, 1981, emphasis on field mapping, structural geology, stratigraphy, and isotope geochronology; thesis advisor: Prof. B.C. Burchfiel.
B.S. in geology, University of California at Santa Cruz, 1977.

Professional Societies: Geological Society of America (Fellow); American Geophysical Union; Arizona Geological Society (2001 President).

Positions Held:

Senior Geologist, Arizona Geological Survey, 1999-present; duties: Acquire federal funding for joint state-federal STATEMAP program; manage spending; supervise field-mapping team and participate in mapping; give talks, write papers, and lead field trips on Arizona geology and mineral resources; study mineral deposits and evaluate potential for new discoveries; provide requested information to interested parties; supervise Oil and Gas Program Administrator; supervise and participate in studies on geologic sequestration of CO_2; identify and apply for funding for study of Arizona's oil, gas, helium, and CO_2 resources.

Acting Director and State Geologist, Arizona Geological Survey, Nov.-Dec., 2005; duties: represent agency to legislators, executive office, and their representatives; supervise staff; oversee budget.

Research Geologist, Arizona Geological Survey, September 1988 to June 1999; duties: field mapping and map and report preparation; manage joint state-federal STATEMAP program; supervise field-mapping team and participate in mapping; manage EPA-funded radon program; give talks and write articles on Arizona geology and mineral resources; acquire external funding.

Assistant Geologist (tenure-track research faculty), Arizona Bureau of Geology and Mineral Technology, University of Arizona; 1982 - 1988; research focused on field mapping and laboratory studies of structurally complex areas in western Arizona, including study of metallic mineral deposits.

NRC Postdoctoral Research Associate, U.S. Geological Survey, Menlo Park, California, September 1981-August 1982; sponsor: K.A. Howard; research focused on field and isotope-geochronologic study of a structurally complex area in the eastern Mojave desert.

Geologist and Physical Science Technician, U.S. Geological Survey, Menlo Park, California, 1977-1981; supervisor: W.R. Normark; primary duties were reduction and interpretation of marine geophysical data; navigator for shipboard scientific party for 2 weeks over the Monterey deep-sea fan.

JON ERIC SPENCER

STATEMAP GEOLOGIC-MAPPING PROGRAM

The National Geologic Mapping Act of 1992 was established to expedite production of geologic maps and to create a national geologic-map database. The Act established the STATEMAP program to award funds to state geological surveys on a competitive, matching-fund basis. Since inception of the STATEMAP Spencer has been responsible for obtaining funding and meeting contract terms for the bedrock mapping component Arizona's STATEMAP program. Awarded funds were matched by an equal or greater amount of State funds appropriated to the Arizona Geological Survey.

Spencer's primary responsibility at the Arizona Geological Survey has been to prepare and submit STATEMAP proposals, supervise contract employees involved in mapping and map and report preparation, manage the STATEMAP budget, and participate fully in field mapping and map preparation (see list of maps below). Through this joint funding mechanism, the AZGS has released over 100 geologic maps and related reports.

STATEMAP contracts to the Arizona Geological Survey

Map areas	Grant period	$ Award	Principal Investigators
Tank Mountains, Palomas Mountains	7/1/93-6/30/94	55,142	Spencer/Richard/Fellows
Florence Junction, Superstition, Theo. Roos. Lake (surficial)	9/1/94-8/31/95	80,000	Spencer/Pearthree/Richard
Apache Junction, San Tan Mts., Theo. Roos. (surficial)	9/22/95-9/20/96	55,000	Spencer/Pearthree/Richard
Superstition bedrock, Casa Grande surficial	9/16/96-9/15/97	120,000	Spencer/Pearthree
Cave Creek/Mazatzal bedrock, Casa Grande surficial	9/16/97-9/15/98	151,036	Spencer/Pearthree/Richard
Sawtooth, Picacho Mts., Ninety Six Hills, Tucson (surficial)	9/16/98-9/15/99	135,577	Spencer/Pearthree/Richard
Greater Tucson (Avra-Roskruge, Green Valley, Oracle)	9/16/99-9/15/00	126,401	Spencer/Pearthree/Richard
Rincon-Empire bed. / Phoenix dig. / Tubac-Amado surficial	9/16/00-9/15/01	145,535	Spencer/Pearthree/Richard
Tortolita / Buckeye Hills / Phoenix area digital	9/16/01-9/15/02	227,325	Spencer/Pearthree/Richard
Sierrita / Huachuca City / west Phoenix digital compilation	9/16/02-9/16/03	235,000	Spencer/Pearthree/Richard
Hassayampa / Vail / Davis Dam / SE Phoenix metro digital	9/17/03-9/16/04	210,665	Spencer/Pearthree/Richard
San Pedro / Wintersburg / east Pima digital	9/17/04-9/17/05	217,439	Spencer/Pearthree/Richard
San Pedro / Yuma / Bullhead City / Maricopa-Pinal digital	9/17/05-9/16/06	197,977	Spencer/Pearthree/Richard
San Pedro / Black Canyon City / Santa Cruz-Cochise digital	9/17/06-9/16/07	202,392	Spencer/Pearthree/Richard
San Pedro/Detrital Valley	9/17/07-9/16/08	215,767	Spencer/Pearthree/Richard
N Santa Rita - S Empire - Sonoita basin / Little Chino Valley / Detrital Valley	9/17/08-9/19/09	217,761	Spencer/Pearthree
Yuma - Big Chino Valley - East Rincon	9/14/09-9/17/10	195,221	Spencer/Pearthree
Detrital Valley – Prescott – Cactus Forest	9/20/10-9/19/11	191,957	Spencer/Pearthree
Artillery-Rawhide – Sullivan Buttes – Safford	9/21/11-9/14/12	189,853	Spencer/Pearthree
Phoenix-area aggregate, Plomosa, southern Bradshaw	9/15/12-9/14/13	206,593	Spencer/Pearthree
		$3,376,641	**Total Arizona STATEMAP**

STATEMAP MAPS

Youberg, Ann, and **Spencer, J.E.,** *in prep*., Geologic map of the Prescott Valley North 7 ½' Quadrangle, Yavapai County, Arizona: Arizona Geological Survey Digital Geologic Map DGM-92, version 1.0, scale 1:24,000. *(submitted to USGS and accepted for terms of contract)*

Spencer, J.E., and Young, J.J., *in prep*., Geologic map of the Jerome Canyon 7 ½' Quadrangle, Yavapai County, Arizona: Arizona Geological Survey Digital Geologic Map DGM-94, version 1.0, scale 1:24,000. *(submitted to USGS and accepted for terms of contract)*

Spencer, J.E., Lingrey, S.H., Johnson, B.J., Cook, J.P., and Richard, S.M., 2011, Geologic map of the Happy Valley 7 ½' Quadrangle, Cochise and Pima Counties, Arizona: Arizona Geological Survey Digital Geologic Map DGM-89, scale 1:24,000.

Youberg, A., **Spencer, J.E.,** and Pearthree, P.A., 2011, Geologic map of the Yuma East 7 ½' Quadrangle, Yuma County, Arizona: Arizona Geological Survey Digital Geologic Map DGM-86, scale 1:24,000.

Pearthree, P.A., Ferguson, C.A., and **Spencer, J.E.**, 2010, Geologic map of the Dolan Spring 7 ½' Quadrangle, Mohave County, Arizona: Arizona Geological Survey Digital Geologic Map DGM-81, scale 1:24,000.

Gootee, B.F., Ferguson, C.A., **Spencer, J.E.,** and Cook, J.P., 2010, Geologic map of the Chino Valley North 7 ½' Quadrangle, Yavapai County, Arizona: Arizona Geological Survey Digital Geologic Map DGM-80, scale 1:24,000.

Spencer, J.E., Youberg, A., and Shipman, T.C., 2010, Geologic map of the Spring Water Canyon 7 ½' Quadrangle Pima County, Arizona: Arizona Geological Survey Digital Geologic Map DGM-79, scale 1:24,000.

Ferguson, C.A., Johnson, B.J., Pearthree, P.A., **Spencer, J.E.,** Shipman, T.C., and Cook, J.P., 2009, Geologic map of the Helvetia 7 ½' Quadrangle, Pima County, Arizona: Arizona Geological Survey Open-File Report 09-06, version 1.0, scale 1:24,000.

Ferguson, C.A., Johnson, B.J., Pearthree, P.A., and **Spencer, J.E.**, 2009, Geologic map of the Grasshopper Junction 7 ½' Quadrangle, Mohave County, Arizona: Arizona Geological Survey Digital Geologic Map DGM-70, scale 1:24,000.

Pearthree, P.A., Cook, J.P., Skotnicki, S.J., and **Spencer, J.E.**, 2009, Geologic map of the Peppersauce Wash 7 ½' Quadrangle and part of the Kielberg Canyon 7 ½' Quadrangle, Pinal and Pima Counties, Arizona: Arizona Geological Survey Digital Geologic Map DGM-69, scale 1:24,000.

Gootee, B.F., **Spencer, J.E.**, Ferguson, C.A., Richard, S.M., Cook, J.P., and MacFarlane, B.J., 2009, Geologic map of the Clark Ranch 7 ½' Quadrangle and the west half of the Rhodes Peak 7 ½' Quadrangle, Pinal and Graham Counties, Arizona: Arizona Geological Survey Digital Geologic Map DGM-68, scale 1:24,000.

Spencer, J.E., Gootee, B.F., Richard, S.M., and Cook, J.P., 2009, Geologic map of the Mammoth 7 ½' Quadrangle, Pinal County, Arizona: Arizona Geological Survey Digital Geologic Map DGM-67, scale 1:24,000.

Young, J.J., **Spencer, J.E.**, MacFarlane, B.J., and Richard, S.M., 2009, Geologic map of the Lookout Mountain 7 ½' Quadrangle, Pinal County, Arizona: Arizona Geological Survey Digital Geologic Map DGM-66, scale 1:24,000.

Cook, J.P., and **Spencer, J.E.**, 2008, Geologic map of the Redington 7 ½' Quadrangle, Cochise, Graham, and Pima Counties, Arizona: Arizona Geological Survey Digital Geologic Map DGM-60, scale 1:24,000.

Spencer, J.E., Richard, S.M., Cook, J.P., Dickinson, W.R., Lingrey, S.H., and Guynn, J.H., 2008, Geologic map of the Soza Canyon 7 ½' Quadrangle, Cochise and Pima Counties, Arizona: Arizona Geological Survey Digital Geologic Map DGM-61, scale 1:24,000.

Spencer, J.E., Cook, J.P., Lingrey, S.H., Richard, S.M., Ferguson, C.A., and Guynn, J.H., 2008, Geologic map of the Wildhorse Mountain 7 ½' Quadrangle, Cochise County, Arizona: Arizona Geological Survey Digital Geologic Map DGM-62, scale 1:24,000.

Ferguson, C.A., Haddad, D.E., Johnson, B.J., Guynn, J.H., **Spencer, J.E.**, and Eddy, D.L., 2008, Geologic map of the east half of the Black Canyon City 7 ½' Quadrangle and the west half of the Squaw Creek Mesa 7 ½' Quadrangle, Maricopa and Yavapai Counties, Arizona: Arizona Geological Survey Digital Geologic Map DGM-64, scale 1:24,000.

Spencer, J.E., Ferguson, C.A., Pearthree, P.A., and Richard, S.M., 2007, Geologic map of the Boundary Cone 7 ½' Quadrangle, Mohave County, Arizona: Arizona Geological Survey Digital Geologic Map DGM-54, layout scale 1:24,000, with 23 p. text.

Shipman, T.C., Richard, S.M., and **Spencer, J.E.**, 2006, Geologic map of the Fortuna 7 ½' Quadrangle, Yuma County, Arizona: Arizona Geological Survey Digital Geologic Map DGM-55, layout scale 1:24,000, with 13 p. text.

Youberg, A., **Spencer, J.E.**, and Richard, S.M., 2006, Geologic map of the Galleta Flat East 7 ½' Quadrangle, Cochise County, Arizona: Arizona Geological Survey Digital Geologic Map 56, layout scale 1:24,000, with 7 p. text.

Spencer, J.E., Youberg, A., and Ferguson, C.A., 2005, Geologic map of the Flatiron Mountain 7 ½' Quadrangle, Maricopa County, Arizona: Arizona Geological Survey Digital Geologic Map DGM-46, scale 1:24,000.

Ferguson, C.A., Shipman, T.C., Moore, E.C., Richard, S.M., and **Spencer, J.E.**, 2005, Geologic map of the Fairbank 7 ½' Quadrangle, Cochise County, Arizona: Arizona Geological Survey Digital Geologic Map DGM-50, scale 1:24,000.

Ferguson, C.A., **Spencer, J.E.,** Pearthree, P.A., Youberg, A., and Field, J.J., 2004, Geologic map of the Wagner Wash Well 7 ½' Quadrangle, Maricopa County, Arizona: Arizona Geological Survey Digital Geologic Map 38 (DGM-38), scale 1:24,000, with 7 p. text.

Pearthree, P.A., Youberg, A., Field, J.J., Ferguson, C.A., and **Spencer, J.E.,** 2004, Geologic map of the Daggs Tank 7 ½' Quadrangle, Maricopa County, Arizona: Arizona Geological Survey Digital Geologic Map 39 (DGM-39), scale 1:24,000.

Youberg, A., **Spencer, J.E.,** and Ferguson, C.A., 2004, Geologic map of the Star Well 7 ½' Quadrangle, Maricopa County, Arizona: Arizona Geological Survey Digital Geologic Map 42 (DGM-42), scale 1:24,000.

Richard, S.M., **Spencer, J.E.,** Youberg, A., and Ferguson, C.A., 2004, Geologic map of the Rincon Valley area, Pima County, Arizona: Arizona Geological Survey Digital Geologic Map 44 (DGM-44), scale 1:24,000.

Spencer, J.E., and Pearthree, P.A., 2004, Geologic map of the Oro Valley 7 ½' Quadrangle, Pima County, Arizona: Arizona Geological Survey Digital Geologic Map 21, version 2.0, scale 1:24,000.

Spencer, J.E., Leighty, R.S., Conway, C.M., Ferguson, C.A., and Richard, S.M., 2004, Compilation geologic map of the Reno Pass area, central Mazatzal Mountains, Maricopa and Gila Counties, Arizona: Arizona Geological Survey Open-File Report 04-03, scale 1:24,000, with 18 p. text.

Spencer, J.E., Ferguson, C.A., Richard, S.M., and Youberg, A., 2003, Geologic map of the Esperanza Mill 7 ½' Quadrangle, Pima County, Arizona: Arizona Geological Survey Digital Geologic Map DGM-33, scale 1:24,000.

Richard, S.M., **Spencer, J.E.,** Youberg, A., and Johnson, B.J., 2003, Geologic map of the Twin Buttes 7 ½' Quadrangle, Pima County, Arizona: Arizona Geological Survey Digital Geologic Map DGM-31, scale 1:24,000.

Spencer, J.E., Richard, S.M., Youberg, A., Ferguson, C.A., and Orr, T.R., 2002, Geologic map of the Chief Butte 7 ½' Quadrangle, southeastern Pinal County, Arizona: Arizona Geological Survey Digital Geologic Map 22, scale 1:24,000.

Richard, S.M., Youberg, A., **Spencer, J.E.,** and Ferguson, C.A., 2002, Geologic map of the Durham Hills 7 ½' Quadrangle, southeastern Pinal County, Arizona: Arizona Geological Survey Digital Geologic Map 19, scale 1:24,000.

Orr, T.R., DeLong, S.B., **Spencer, J.E.,** and Richard, S.M., 2002, Geologic map of the Fortified Peak 7 ½' Quadrangle, southeastern Pinal County, Arizona: Arizona Geological Survey Digital Geologic Map 18, scale 1:24,000.

Orr, T.R., Shipman, T.C., and **Spencer, J.E.,** 2002, Geologic map of the North of Oracle 7 ½' Quadrangle, southeastern Pinal County, Arizona: Arizona Geological Survey Digital Geologic Map 23, scale 1:24,000.

Ferguson, C.A., Johnson, B.J., Skotnicki, S.J., Maher, D.J., **Spencer, J.E.,** Gilbert, W.G., Richard, S.M., and Youberg, A., 2002, Geologic map of the Tortolita Mountains, Pinal and Pima Counties, Arizona: Arizona Geological Survey Digital Geologic Map 26, scale 1:24,000.

Ferguson, C.A., Youberg, A., Gilbert, W.G., Orr, T.M., Richard, S.M., and **Spencer, J.E.,** 2001, Geologic map of the Mount Fagan 7.5' Quadrangle, eastern Pima County, Arizona: Arizona Geological Survey Digital Geologic Map 11, layout scale 1:24,000, with 33 page text (revised May, 2002).

Spencer, J.E., Ferguson, C.A., Richard, S.M., Orr, T.R., Pearthree, P.A., Gilbert, W.G., and Krantz, R.W., 2001, Geologic map of The Narrows 7 ½' Quadrangle and the southern part of the Rincon Peak 7 ½' Quadrangle, eastern Pima County, Arizona: Arizona Geological Survey Digital Geologic Map 10, layout scale 1:24,000, with 32 p. text (revised May, 2002).

Richard, S.M., **Spencer, J.E.,** Ferguson, C.A., Youberg, A., 2001, Geologic map of southern part of the Vail 7 ½' Quadrangle, eastern Pima County, Arizona: Arizona Geological Survey Digital Geologic Map 12 (DGM 12), layout scale 1:24,000, with 29 p. text (revised July, 2002).

Spencer, J.E., Richard, S.M., and Ferguson, C.A., 2000, Compilation geologic map of the Oracle 7 ½' Quadrangle, Pinal and Pima Counties, Arizona: Arizona Geological Survey Open-File Report 00-05, scale 1:24,000 (1 sheet), 30 p.

Richard, S.M., Ferguson, C.A., **Spencer, J.E.,** Youberg, A., and Orr, T.R., 2000, Geologic map of the Waterman Peak 7.5' Quadrangle and northern La Tortuga Butte 7.5' Quadrangle, Pima County, Arizona: Arizona Geological Survey Digital Geologic Map 2, scale 1:24,000, 24 p.

Ferguson, C.A., Gilbert, W.G., Orr, T.R., **Spencer, J.E.,** Richard, S.M., and Pearthree, P.A., 1999, Geologic map of the Samaniego Hills, Pinal and Pima Counties, southern Arizona: Arizona Geological Survey Open-File Report 99-17, 1 plate, scale 1:24,000, with 15 p. text.

Richard, S.M., **Spencer, J.E.,** Ferguson, C.A., and Pearthree, P.A., 1999, Geologic map of the Picacho Mountains and Picacho Peak, Pinal County, southern Arizona: Arizona Geological Survey Open-File Report 99-18, 1 plate, scale 1:24,000, with 43 p. text.

Spencer, J.E., Richard, S.M., Ferguson, C.A., and Gilbert, W.G., 1999, Preliminary bedrock geologic map and cross section of the Windy Hill 7 ½' Quadrangle, Gila County, Arizona: Arizona Geological Survey Open-File Report 99-12, scale 1:24,000.

Spencer, J.E., Richard, S.M., Ferguson, C.A., and Gilbert, W.G., 1999, Geologic map of the northwestern part of the Greenback Creek 7 ½' Quadrangle, Gila County, Arizona: Arizona Geological Survey Open-File Report 99-10, scale 1:24,000.

Spencer, J.E., and Richard, S.M., 1999, Geologic map and report for the Theodore Roosevelt Dam area, Gila and Maricopa Counties, Arizona: Arizona Geological Survey Open-File Report 99-6, scale 1:24,000, 28 p.

Richard, S.M., and **Spencer, J.E.**, 1998, Compilation geologic map of the Ray-Superior area, central Arizona: Arizona Geological Survey Open-File Report 98-13, scale 1:24,000, 47 p.

Spencer, J.E., and Gilbert, W.G., 1997, Geologic maps of parts of the Gila Bend Mountains near Woolsey Peak and Signal Mountain, southwestern Arizona: Arizona Geological Survey Open-File Report 97-8, scale 1:24,000.

Richard, S.M., and **Spencer, J.E.**, 1997, Geologic map of the North Butte 7 ½' Quadrangle and the northeastern part of the Florence SE 7 ½' Quadrangle, southeastern Arizona: Arizona Geological Survey Open-File Report 97-4, scale 1:24,000, 18 p.

Spencer, J.E., Richard, S.M., and Pearthree, P.A., 1996, Geologic map of the Mesa 30' x 60' Quadrangle, east-central Arizona: Arizona Geological Survey, Open-File Report 96-23, scale 1:100,000.

Spencer, J.E., 1995, Geologic map of the Little Horn 30' x 60' Quadrangle, southwestern Arizona: Arizona Geological Survey, Open-File Report 95-1, scale 1:100,000.

Spencer, J.E., and Richard, S.M., 1995, Geologic map of the Picketpost Mountain and the southern part of the Iron Mountain 7.5' Quadrangles, Pinal County, Arizona: Arizona Geological Survey, Open-File Report 95-15, 12 p., scale 1:24,000.

Richard, S.M., and **Spencer, J.E.**, 1994, Detailed geologic map and cross sections of the Ramsey Mine area, southeastern Plomosa Mountains, west-central, Arizona: Arizona Geological Survey Open-File Report 94-14, 16 p., scale 1:12,000.

Ferguson, C.A., Skotnicki, S.J., and **Spencer, J.E.**, 1994, Bedrock geology of the eastern and central Tank Mountains, Yuma County, Arizona: Arizona Geological Survey Open-File Report 94-8, 33 p., scale 1:24,000.

Richard, S.M., **Spencer, J.E.**, and Reynolds, S.J., 1994, Geologic map of the Salome 30' x 60' Quadrangle, west-central Arizona: Arizona Geological Survey Open-File Report 94-17, 33 p., 1 sheet, scale 1:100,000.

JON ERIC SPENCER

OIL AND GAS PROGRAM

Spencer has served as supervisor for Oil and Gas Program Administrator Steve Rauzi and provides occasional oversight for ongoing regulatory and investigative activities. Current involvement in CO_2 sequestration research is done with AZGS matching funds committed to contracted projects (COTSA; WESTCARB; RMCCS).

OIL AND GAS

Spencer, J.E., and Rauzi, S.L., 2005, Drill holes in the Luke salt body penetrate underlying fault: Arizona Geology, v. 35, n, 3., p. 1-4.

GEOLOGIC SEQUESTRATION OF CARBON DIOXIDE

Publications

Spencer, J.E., 2011, Preliminary evaluation of Cenozoic basins in Arizona for CO_2 sequestration potential: Arizona Geological Survey, Open-File Report OFR-11-05, version 1.1,15 p.

Spencer, J.E., 2011, Preliminary evaluation of Cenozoic basins in Arizona for CO_2 sequestration potential: Arizona Geology, v. 41, n. 1 (Spring 2011).

Rauzi, S.L., and **Spencer, J.E.**, 2009, Carbon sequestration potential at the 1 Alpine-Federal site in east-central Arizona: Arizona Geological Survey Open-File Report 09-02, 7 p.

CO_2 Sequestration Research Contracts:

CO_2 Sequestration Assessment (COTSA). USGS contract to AZGS for evaluation of CO_2 sequestration potential of the Colorado Plateau. $50,000 awarded, terms of contract satisfied September 2011.

WESTCARB. Award from California Energy Commission ($232,350 awarded for contract period Dec. 1, 2010 to Dec. 1, 2012 for proposal written by Jeri Young). Spencer tasks: provide supervision, advice, review, and oversight for Steve Rauzi and Brian Gootee work on WESTCARB contract, assist Diane Love in budget oversight and weekly reports. Active participation in research leading to publications (e.g., OFR-11-05, listed above).

Rocky Mountain Carbon Capture and Sequestration (RMCCS). Award from University of Utah ($142,799 awarded for budget year 2; $8910 matching funds): Supervise Steve Rauzi and subordinates Jefferson Lee and Geneveive Pearthree to meet the terms of the contract. Participate in preparation of deliverables. Prepare and track budget.

HELIUM

Spencer, J.E., 1983, Helium: Origin, use, supply, and demand, *in* Fieldnotes: Arizona Bureau of Geology and Mineral Technology, v. 13, no. 2, p. 1-5.

Spencer, J.E., 1983, Helium resources and production in Arizona, *in* Fieldnotes: Arizona Bureau of Geology and Mineral Technology, v. 13, no. 2, pgs. 6-7, 15-16.

JON ERIC SPENCER

RADON AND URANIUM

Uranium

Spencer, J.E., and Wenrich, K., 2011, Breccia-pipe uranium mining in the Grand Canyon region and implications for uranium levels in Colorado River water: Arizona Geological Survey Open-File Report OFR-11-04, version 1.0, 13 p.

Spencer, J.E., 2002, Naturally occurring radioactive materials (NORM) in Arizona: Arizona Geological Survey Open-File Report 02-13, 11 p. *(This report was written after a request for information from the Arizona Mining Association. New environmental regulations had been proposed that would regulate "technologically enhanced, naturally occurring radioactive materials" (TENORM), which consist primarily of mine waste in which uranium and its decay products are in greater concentrations due to mineral processing).*

Radon

In the early 1980s it was discovered that indoor air can acquire alarmingly high levels of radioactive radon gas and its short-lived decay products ultimately originating from radioactive decay of naturally occurring uranium in soil and rock beneath homes and buildings. Lung cancer is the only known hazard from long-term radon exposure. The U.S. Environmental Protection Agency, through the State Indoor Radon Grant (SIRG) program, funded state programs aimed at identifying radon hazards and reducing human exposure. Funds from this program, and from a special state appropriation, were used by the Arizona Geological Survey primarily to identify areas in the state where underlying uranium levels are anomalously high.

It was my responsibility to acquire funding from the SIRG program (see table below), manage grant funds so that projects were completed within budgetary limits and timelines, hire and supervise employees (usually one) to carry out field studies and write up results of investigations, review maps and reports, write technical reports, write reports directed at educating the public about radon hazards and geologic aspects of radon (see list on next page), and occasionally provide information and interviews to newspaper, television, and radio reporters.

Awards to the Arizona Geological Survey for Study of Radon

Radon and uranium	Year	$ Award	Principal Investigator
Uranium levels in rock and soil (special appropriation from AZ legislature)	1988	8000	Spencer
Uranium levels in rock and soil (EPA)	1990	2502	Spencer
Uranium levels in rock and soil (EPA)	1991	35062	Spencer
Uranium levels in rock and soil (EPA)	1992	27052	Spencer
Uranium levels in rock and soil (EPA)	1993	20172	Spencer
Uranium levels in rock and soil (EPA)	1994	17789	Spencer
Uranium levels in rock and soil (EPA)	1995	17001	Spencer
Uranium levels in rock and soil (EPA)	1996	24015	Spencer
Uranium levels in rock and soil (EPA)	1997	26432	Spencer
Uranium levels in rock and soil (EPA)	1998	26338	Spencer
Uranium levels in rock and soil (EPA)	1999	4790	Spencer
		$209,153	**Total**

RADON-RELATED PUBLICATIONS

Spencer, J.E., 1992, Radon gas: A geologic hazard in Arizona: Arizona Geological Survey, Down-to-Earth Series, n. 2, 17 p.

Spencer, J.E., 1993, editor, Radon in Arizona: Arizona Geological Survey Bulletin 199, 96 p., 2 plates.

Includes the following articles:

Spencer, J.E., 1993, Geology and radon in Arizona: Introduction and overview, *in* Spencer, J.E., ed., Radon in Arizona: Arizona Geological Survey Bulletin 199, p. 1-9.

Spencer, J.E., Emer, D.F., and Shenk, J.D., 1993, Geology, radioactivity, and radon at the Cardinal Avenue uranium anomaly, southwestern Tucson, *in* Spencer, J.E., ed., Radon in Arizona: Arizona Geological Survey Bulletin 199, p. 10-17.

Duncan, J.T., and **Spencer, J.E.**, 1993, Uranium and radon in southeastern Arizona, *in* Spencer, J.E., ed., Radon in Arizona: Arizona Geological Survey Bulletin 199, p. 40-43.

Duncan, J.T., and **Spencer, J.E.**, 1993, Investigations of uranium and radon in the Phoenix metropolitan area, *in* Spencer, J.E., ed., Radon in Arizona: Arizona Geological Survey Bulletin 199, p. 43-50.

Duncan, J.T., and **Spencer, J.E.**, 1993, Uranium-bearing rocks in Verde Valley, Yavapai County, and implications for indoor-radon gas, *in* Spencer, J.E., ed., Radon in Arizona: Arizona Geological Survey Bulletin 199, p. 51-56.

Duncan, J.T., and **Spencer, J.E.**, 1993, Uranium and radon in the Prescott area, Yavapai County, *in* Spencer, J.E., ed., Radon in Arizona: Arizona Geological Survey Bulletin 199, p. 57-60.

Duncan, J.T., **Spencer, J.E.**, Eshraghi, P., and Emrick, S.M., 1993, A reconnaissance study of radon and other radionuclides in Arizona well water, *in* Spencer, J.E., ed., Radon in Arizona: Arizona Geological Survey Bulletin 199, p. 86-92.

Duncan, J.T., and **Spencer, J.E.**, 1993, A survey of uranium concentrations in rocks and soils in populated areas of Arizona: Methods, *in* Spencer, J.E., ed., Radon in Arizona: Arizona Geological Survey Bulletin 199, p. 93-96.

Spencer, J.E., Shenk, J.D., and Duncan, J.T., 1993, Areas in Arizona with elevated concentrations of uranium, *in* Spencer, J.E., ed., Radon in Arizona: Arizona Geological Survey Bulletin 199, Plate 1, scale 1:1,000,000.

Duncan, J.T., and **Spencer, J.E.**, 1993, Geology and uranium concentrations in Verde Valley, Yavapai County, Arizona, *in* Spencer, J.E., ed., Radon in Arizona: Arizona Geological Survey Bulletin 199, Plate 2, scale 1:32,200.

Other Radon and Uranium Reports

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JON ERIC SPENCER

GEOLOGIC EVOLUTION OF THE COLORADO RIVER, GRAND CANYON, AND COLORADO PLATEAU

Since at least 1960 it had been thought that the Bouse Formation in the lower Colorado River Valley represented a marine incursion almost to Las Vegas that was associated with early rifting in the Gulf of California. Spencer and Patchett (1997) reinterpreted the Bouse Formation as lacustrine on the basis of strontium isotopes. This had the effect of undermining previously inferred timing constraints on uplift of the Colorado Plateau, and helped trigger a resurgence of interest in issues associated with Colorado River initiation and Grand Canyon incision.

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JON ERIC SPENCER

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JON ERIC SPENCER

GEOLOGY AND MINERAL DEPOSITS OF WESTERN ARIZONA

From 1982 until 1988, Spencer was in a tenure-track research faculty position at the Geological Survey Branch of the Arizona Bureau of Geology and Mineral Technology, a department within the University of Arizona. On July 1, 1988, the Geological Survey Branch was removed from the University by an act of the State Legislature and renamed the Arizona Geological Survey.

Spencer's research at the University of Arizona, and for several years afterward, focused on determining the geologic history of La Paz and western Maricopa Counties. Poorly understood geologic processes had created the newly discovered Copperstone gold deposit (500,000 oz. gold produced) south of Parker, and many other base- and precious-metal deposits. Geologic mapping and related investigations were intended to clarify the geologic setting and genesis of these deposits (see publication list below). It was hoped that new knowledge would assist mineral exploration companies in finding new deposits.

During this time Spencer developed an excellent understanding of the needs of those involved with mineral exploration, including consultants, prospectors, and exploration and mining companies. Highest on their list of desirable products from a state geological survey were geologic maps of areas with complex geology and potential for undiscovered mineral deposits. Funding for some field studies was provided by the USGS through the joint State-Federal COGEOMAP program (see table below; COGEOMAP was a precursor to STATEMAP).

Spencer's primary responsibilities were in designing research programs, carrying out field research, collaborating with other geologists, preparing maps and reports, and publishing research results in peer-reviewed scientific journals and books. Additional duties included preparing reports on the geology and mineral resources of Arizona, some of which were intended for the non-expert, and assisting interested parties in evaluating mineral resource potential of specific areas.

Federal Awards from the COGEOMAP program

Map areas	Grant period	$ Award	Principal Investigators
Wickenburg Mountains	1/87-12/87	60,000	Reynolds/Spencer/Fellows
Vulture Mountains	3/88-4/89	60,000	Reynolds/Spencer/Fellows
East Gila Bend Mountains	6/90-5/91	40,000	Reynolds/Spencer/Fellows
Cemetery Ridge, western Gila Bend Mts.	7/91-6/92	40,000	Spencer/Reynolds/Fellows
Central Gila Bend Mountains	7/92-6/93	56,018	Spencer/Richard/Fellows
		$256,018	**Total**

MAPS AND PUBLICATIONS ON WESTERN ARIZONA GEOLOGY

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ABSTRACTS

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Spencer, J.E., 1994, Uplift of the Colorado Plateau: Possible mechanisms related to low-angle subduction: Geological Society of America Abstracts with Programs, v. 26, n. 6, p. 64.

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Richard, S. M., and **Spencer, J.E.**, 1993, Mesozoic pre-thrusting high-angle faults and stratigraphic variations, Plomosa Mountains, W. Arizona: Geological Society of America Abstracts with Programs, v. 25, n. 5, p. 138.

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Spencer, J.E., and Reynolds, S.J., 1990, Structural style and magnitude of extension within the southern part of the Colorado River extensional corridor, west-central Arizona: Geological Society of America Abstracts with Programs, v. 22, p. 86.

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Spencer, J.E., 1988, Role of crustal flexure in initiation of detachment faults: Inferences based on Airy stress functions: Geological Society of America Abstracts with Programs, v. 20, p. 234.

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Spencer, J.E., 1987, Reduction of crustal flexural rigidity during folding of crystalline rocks in the Harcuvar and Whipple metamorphic core complexes, west-central Arizona and southeastern California: Geological Society of America Abstracts with Programs, v. 19, p. 853.

Reynolds, S.J., **Spencer, S.J.**, Laubach, S.E., and Richard, S.M., 1987, Mesozoic structural evolution of the Maria fold and thrust belt, west-central Arizona and southeastern California: Geological Society of America Abstracts with Programs, v. 19, p. 818.

Laubach, S.E., Reynolds, S.J., **Spencer, J.E.**, and Richard, S.M., 1986, Thrust-related metamorphism, Granite Wash Mountains, west-central Arizona: Geological Society of America Abstracts with Programs, v. 18, p. 126.

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Richard, S.M., Reynolds, S.J., **Spencer, J.E.**, and Laubach, S., 1986, Regionally penetrative gently dipping faults and fabrics, Harcuvar complex, west-central Arizona: Geological Society of America Abstracts with Programs, v. 18, p. 406.

Welty, J.W., and **Spencer, J.E.**, 1986, Two types of mineral deposits related to Tertiary detachment faults in the southwestern United States: Geological Society of America Abstracts with Programs, v. 18, p. 785.

Richard, S.M., Reynolds, S.J., and **Spencer, J.E.**, 1985, Mesozoic thrust sheets of the Harquahala and Little Harquahala Mountains, western Arizona: Geological Society of America Abstracts with Programs, v. 17, p. 404.

Welty, J.W., and **Spencer, J.E.**, 1985, Geology and industrial uses of Arizona's volcanic rocks: 21st Forum on the Geology of Industrial Minerals, Tucson, Arizona, Arizona Bureau of Geology and Mineral Technology, Program with Abstracts.

Spencer, J.E., and Reynolds, S.J., 1984, Mid-Tertiary crustal extension in Arizona: Geological Society of America Abstracts with Programs, v. 16, p. 664.

Laubach, S.E., Reynolds, S.J., **Spencer, J.E.**, and Marshak, S., 1984, Polyphase deformation history of Mesozoic metasedimentary rocks in western Arizona: Geological Society of America Abstracts with Programs, v. 16, p. 570.

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RECENT PRESENTATIONS

2011

Spencer, J.E., Cenozoic evaporite deposits in Arizona and their known and potential uses: Society for Mining, Metallurgy, and Exploration, Inc., (SME) Arizona Conference, presentation December 5, 2011 at Marriot Starr Pass resort and conference center, Tucson.

Spencer, J.E., Life at the feather edge: Critical taper theory in extensional tectonics: Lecture given at University of Texas at Austin to weekly "Structure/petrology/tectonics seminar", November 9, 2011.

Spencer, J.E., Breccia-pipe uranium deposits in the Grand Canyon region and some environmental aspects of mining: 15-minute PowerPoint presentation at Arizona Mining Association Board Meeting, Arizona Rock Products Building, Phoenix, October 20, 2011.

Spencer, J.E., The Grand Canyon breccia-pipe uranium district, northwestern Arizona, and potential mining-related impacts to Colorado River water quality: Geological Society of America National Meeting, Minneapolis (Paper no. 280-6), October 12, 2011.

Spencer, J.E., Sarna-Wojcicki, A.M., Patchett, P.J., Roskowski, J.A., Pearthree, P.A., House, P.K., and Faulds, J.E., Circa 4.8 Ma age for inception of the modern Colorado River: Geological Society of America National Meeting (Paper no. 189-42), poster presentation, October 11, 2011.

Spencer, J.E., Breccia-pipe uranium deposits in the Grand Canyon region and some environmental aspects of mining: 15-minute PowerPoint presentation to Arizona Mining Caucus, Granite Construction Company offices, Tucson, July 14, 2011.

Spencer, J.E., The Grand Canyon breccia-pipe uranium province, northwestern Arizona, and some environmental aspects of mining: Tucson, Arizona Nuclear Society, 30-minute presentation at El Parador Restaurant, June 10, 2011.

Spencer, J.E., The Grand Canyon breccia-pipe uranium province, northwestern Arizona, and some environmental aspects of mining: Phoenix, Arizona Nuclear Society, 30-minute presentation in the State Senate Majority Caucus Room, May 25, 2011.

Spencer, J.E., Life at the feather edge: Critical taper theory in extensional tectonics. Lecture given to University of Arizona Geophysical Society (graduate student organization) February 4, 2011.

2010

Spencer, J.E. (presenter), and Wenrich, K.J. (abstract co-author), Breccia-pipe uranium mineralization in the Grand Canyon region, and some environmental aspects of mining: Society for Mining, Metallurgy, and Exploration, Inc., Arizona Conference, presentation December 6, 2010 at Hilton El Conquistador, Tucson.

Spencer, J.E., Geologic continuous casting and core-complex genesis, 45-minute presentation at University of Texas, El Paso (Geology Department Graduate Seminar). October 21, 2010.

Spencer, J.E. (presenter), and Wenrich, K.J. (abstract co-author), 2010, The Grand Canyon breccia-pipe uranium province, northwestern Arizona: Tucson, Arizona Hydrological Society, Annual Symposium (Dryland Hydrology: Global Challenges, Local Solutions, September 1-4, 2010), proceedings on CD-ROM.

Spencer, J.E., Lake spillover hypothesis for river integration and the significance of the Bouse Formation in the lower Colorado River trough: Ten minute presentation at USGS sponsored symposium: Origin and Evolution of the Colorado River System II: Flagstaff, Arizona, May 24, 2010.

2009

Spencer, J.E., Reconstruction of Cenozoic Tectonic Extension in Southeastern Arizona and Implications for Porphyry-Copper Exploration: SME Tucson Chapter –December 7, 2009

Spencer, J.E., Yale University - Department of Geology - tectonics seminar: Geologic continuous casting, core-complex exhumation, and critical-taper theory: 1 hour talk, Nov. 2, 2009, New Haven, Connecticut

Spencer, J.E., American Museum of Natural History - Dept. Earth and Planetary Sciences - geology seminar: Geologic continuous casting, core-complex exhumation, and critical-taper theory. 1 hour talk, Oct. 30, 2009, New York, NY

Spencer, J.E., Columbia University - Lamont-Doherty Earth Observatory - tectonics seminar: Geologic continuous casting, core-complex exhumation, and critical-taper theory, 1 hour talk, Oct. 29, 2009, Palisades, NY

Spencer, J.E., Arizona Geological Society, monthly dinner meeting: Restoration of Cenozoic dismemberment of porphyry copper deposits in southeastern Arizona, 1 hour talk, July 7, 2009.

2008

Spencer, J.E., SME Arizona Conference: Spencer, J.E., and Richard, S.M., Structural geology of the San Manuel and Mammoth mining districts north of Tucson – 30 minute oral presentation by Spencer at SME Arizona Conference, Hilton El Conquistador Resort, Oro Valley, AZ (Dec. 8, 2008)

Spencer, J.E., University of Arizona College of Public Health: Seminar class 696R - Environmental and Occupational Health: "Radon gas: A geologic hazard that no one can completely avoid," 45 minute lecture given Sept. 24, 2008

Spencer, J.E., "Geology and uses of copper": Presentation (20 minutes) to Pima Association of Governments, Tucson, June 30, 2008.

Spencer, J.E., "Extent and age of the Bouse Formation as indicated by strontium isotopes and tephrochronology in Blythe basin": Presentation at California State University Desert Studies Center, Zzyzx, California: Symposium title: "Trough to trough: The Colorado River and the Salton Sea", April 19, 2008.

Spencer, J.E., "Influence of the Maria fold and thrust belt on styles of Oligo-Miocene extension in western Arizona: Application of critical-taper theory": Geological Society of America joint meeting of the Cordilleran and Rocky Mountain sections, Las Vegas, Nevada, March 20, 2008.

Spencer, J.E., "The Espiritu Canyon shear zone in the footwall of the San Pedro – Catalina detachment fault east of Tucson, Arizona: An exhumed, deep-seated segment of the San Xavier detachment fault?": Geological Society of America joint meeting of the Cordilleran and Rocky Mountain sections, Las Vegas, Nevada, March 20, 2008.

2007

Spencer, J.E., "Circum-Pacific Continuous Casting": Arizona Geological Society Ores and Orogenesis Symposium, unscheduled presentation to fill in for no-show in South American Tectonics Session (September 29, 2007).

Spencer, J.E., "Tectonics of the Southwest" for UA class on tectonics taught by Mihai Ducea, October 11, 2007.

Spencer, J.E., "Crust with a memory: Three generations of tectonics in the eastern Mohave Desert of western Arizona and southeastern California" Presentation (50 minutes) to University of Michigan geology department, November 5, 2007

JON ERIC SPENCER

RECENT SERVICE TO COMMUNITY AND PROFESSIONAL GROUPS

Video Interview – Vail Preservation Society – Geology of the Rincon, Empire, and Santa Rita Mountains (March 8, 2012)

Represent AZGS as a cooperating agency in US Forest Service preparation of an Environmental Impact Statement for the proposed Rosemont Mine in the Santa Rita Mountains southeast of Tucson.

Represent AZGS as a cooperating agency in US Bureau of Land Management preparation of an Environmental Impact Statement for proposed withdrawal of approximately one million acres of public land from new mining activity in the area around the Grand Canyon.

TV interview – NHK (Japan Public Television) Sonoran Desert geology, July 20, 2011 (interview in my office)

Phone interview – Wall Street Journal – Breccia pipe uranium deposits in northern Arizona, phone interview Sept. 13, 2011

Serve on Ph.D. dissertation review committee for University of Texas at Austin. Geology graduate student John Singleton (dissertation on western Arizona geology [Buckskin Mountains – structural geology]) completed 2011

Lead field trip along Catalina Highway for University of Texas Professor Sharon Mosher and graduate student in search of Ph.D. thesis project in Arizona, March 17, 2010.

Official judge of presentations at two sessions of GeoDaze (student symposium of current research), Department of Geosciences, University of Arizona, April 1, 2010.

Lead field trip across Santa Catalina Mountains for UA prof. Jon Patchett and student – sample collecting for senior thesis and development of new analytical tools at UA (Lu-Hf analysis by LA-ICP-MS), Oct. 16, 2009.

Alhurra Arabic-language satellite-TV: Field interview for news show (recorded) Jan. 28, 2009.

National Public Radio: Phone interview about Tucson area geology (Sept. 2, 2008)

Tucson Citizen (newspaper): Interview with Brad Poole regarding age and origin of the Grand Canyon (Sept. 19, 2008).

New York Times: Interview with John Randolf on "Why does Arizona have so much copper" October 23, 2008).

Earth Magazine: Interview with Erin Wayman on age and origin of the Grand Canyon (Nov. 10, 2008).

University of Arizona: Serve on thesis committee for M.S. student Jennifer Roskowski.

Core complex geology along the Catalina Highway, for Arizona Geological Society Spring Field Trip (April 26, 2008).

Bouse Formation in lower Colorado River trough. Lead field trip to two stops for 3-day, post-symposium field trip. Symposium title: "Trough to trough: The Colorado River and the Salton Sea" (April 20, 2008).

AGS. Arizona Geological Society (AGS): Serve as editor (with co-editor Spencer Titley) of Arizona Geological Society Digest 22 (618 pages, 44 chapters).

AGS. Arizona Geological Society (AGS): Assemble layout version (in Adobe InDesign) for Arizona Geological Society Digest 22, and work with commercial printer to insure complete and accurate implementation of layout during printing (1000 hardbound books printed).

AGS. Arizona Geological Society 2007 Dickinson Symposium, Program Committee: Serve as co-chair for tectonics (with Bob Kamilli who was in charge of Economic Geology presentations). As program chair for the tectonics talks, I invited 72 speakers and reviewed about 100 abstracts. Additional duties include scheduling and communicating with speakers about scheduling, financial issues, and the subject matter of sessions and presentations.

AGS. Core complex geology along the Catalina Highway, for Arizona Geological Society Ores and Orogenesis Symposium (September 25, 2007).

AGS. Arizona Geological Society (AGS) Councilor (2003-2008), past President (2002), President (2001).

Core complex geology along the Catalina Highway for U Texas El Paso graduate-level class in tectonics (April 16, 2007)

Core complex geology along the Catalina Highway for UA tectonics and thermochronology group (April 20, 2007)

Video interview with Pioneer Productions (London) on origin of the Colorado River and Grand Canyon

JON ERIC SPENCER

GEOLOGIC PUBLICATIONS UNRELATED TO AZGS ACTIVITIES

Spencer, J.E., 2011, Gently dipping normal faults identified with Space Shuttle radar topography data in central Sulawesi, Indonesia, and some implications for fault mechanics: Earth and Planetary Science Letters, v. 308, p. 267-276.

Spencer, J.E., 2010, Structural analysis of three extensional detachment faults with data from the 2000 Space-Shuttle Radar Topography Mission: GSA Today, v. 26, n. 8, p. 4-10.

Spencer, J.E., 2001, Possible giant metamorphic core complex at the center of Artemis Corona, Venus: Geological Society of America Bulletin, v. 113, p. 333-345.

Spencer, J.E., 1990, Late Cenozoic extensional and compressional tectonism in the southern and western Avawatz Mountains, southeastern California, *in* Wernicke, B.P., ed., Basin and Range extensional tectonics near the latitude of Las Vegas, Nevada: Geological Society of America Memoir 176, p. 317-333.

Spencer, J.E., 1990, Geologic map of the southern Avawatz Mountains, northeastern Mohave Desert region, California: U.S. Geological Survey Miscellaneous Field Studies Map MF-2117, scale 1:24,000.

Spencer, J.E., and Normark, W.R., 1989, Neogene plate tectonic evolution of the Baja California Sur continental margin and the southern Gulf of California, Mexico, *in* Winterer, E.L., and others, eds., The Eastern Pacific Ocean and Hawaii: Geological Society of America, The Geology of North American, v. N, p. 489-497.

Normark, W.R., **Spencer, J.E.,** and Ingle, J.C., Jr., 1987, Geology and Neogene history of the Pacific continental margin of Baja California Sur, Mexico, *in* Geology and resource potential of the continental margin of western North America and adjacent ocean basins -- Beaufort Sea to Baja California: Circum-Pacific Council for Energy and Mineral Resources, Earth Science Series, v. 6, p. 449-472.

Spencer, J.E., 1987, K-Ar thermochronology of a Mesozoic plutonic complex, Avawatz Mountains, southeastern California: Isochron/West, no. 48, p. 3-7.

Spencer, J.E., 1985, Miocene low-angle normal faulting and dike emplacement at Homer Mountain and surrounding areas, southeastern California and southernmost Nevada: Geological Society of America Bulletin, v. 96, p. 1140-1155.

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Wernicke, B., **Spencer, J.E.,** Burchfiel, B.C., and Guth, P.L., 1982, Magnitude of extension in the southern Great Basin: Geology, v. 10, p. 499-502.

Spencer, J.E., 1982, Origin of folds of Tertiary low-angle fault surfaces, southeastern California and western Arizona, *in* Frost, E.G., and Martin, D.L., eds., Mesozoic-Cenozoic tectonic evolution of the Colorado River region, California, Arizona, and Nevada: San Diego, Cordilleran Publishers, p. 123-134.

Spencer, J.E., and Turner, R.D., 1982, Dike swarms and low-angle faults, Homer Mountain and the northwestern Sacramento Mountains, southeastern California, *in* Frost, E.G., and Martin, D.L., eds., Mesozoic-Cenozoic tectonic evolution of the Colorado River region, California, Arizona, and Nevada: San Diego, Cordilleran Publishers, p. 97-108.

Spencer, J.E., and Normark, W.R., 1979, Tosco-Abreojos fault zone: A Neogene transform plate boundary within the Pacific margin of southern Baja California, Mexico: Geology, v. 7, p. 554-557.

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Spencer, J.E., 1999, Possible giant metamorphic core complex at the center of Artemis Corona, Venus, and some tectonic implications: EOS, American Geophysical Union, Fall meeting abstracts, p. F629.

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Spencer, J.E., 1983, Miocene dike emplacement and low-angle faulting in the northern Sacramento Mountains, Homer Mountain and adjacent areas, California and Nevada: Geological Society of America Abstracts with Programs, v. 15, p. 384.

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Spencer, J.E., 1981, Lower Paleozoic stratigraphy of the Avawatz Mountains, northeastern Mojave desert region, California: Geological Society of America Abstracts with Programs, v. 13, p. 107.

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Burchfiel, B.C., Cameron, C.S., Guth, P.L., **Spencer, J.E.**, Carr, M.D., Miller, E.L., McColloh, T.S., 1980, A Triassic overlap assemblage in northern Mojave/Death Valley region, California: An interpretation: Geological Society of America Abstracts with Programs, v. 12, p. 395.

Spencer, J.E., and Normark, W.R., 1979, The Neogene Tosco-Abreojos strike-slip fault within the Pacific margin of southern Baja California, Mexico: Geological Society of America Abstracts with Programs, v. 11, p. 129.